

Cable-wrap: what it is and how to deal with it

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May 2013 TOW

Definitions

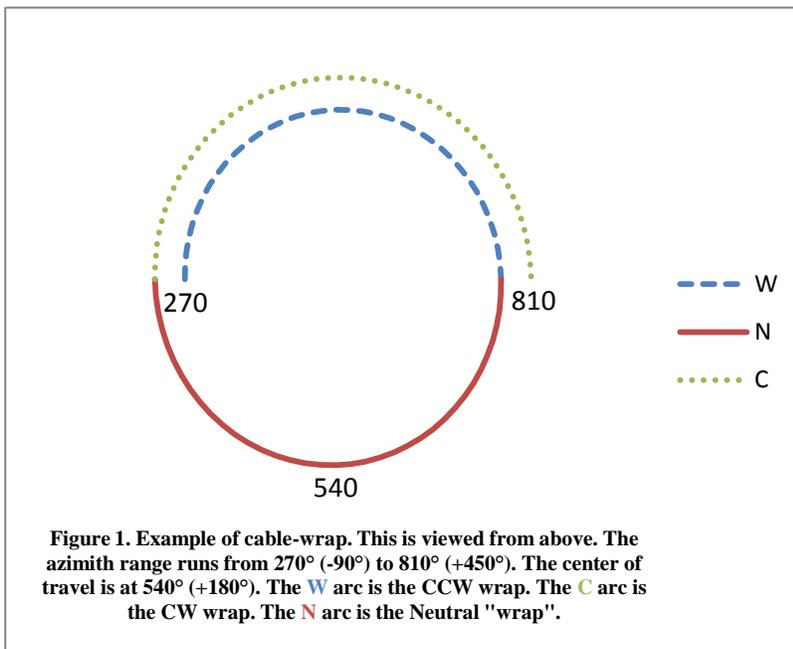
There are two regions in azimuth: "Neutral" and "Overlap". Azimuths in the "Neutral" region can only be reached in one way. Azimuths in the "Overlap" region can be reached in two ways, called "wraps". The wraps are identified as, viewed from above:

- Counter-clockwise (CCW or W) – the CCW part of the Overlap region
- Clockwise (CW or C) – the CW part of the Overlap region

The "Neutral" (N) region is conventionally considered to be a "wrap" itself. Please see Figure 1. Total azimuth travel is limited to be less than full two turns for our purposes, but at least more than one full turn (plus 4° due to exclusion zones used by SKED, see below).

In the SKED antenna catalog, the limits of the cable-wrap are expressed as positive numbers. For example, an azimuth range of -90° to +450° (one and a half turns centered on 180°) is represented as 270° to 810°, which has a center of 540°. The azimuth values used are true local coordinates, as opposed to antenna coordinates.

Please note that some antennas may accept new commands only up to some wrap "limits" in azimuth,

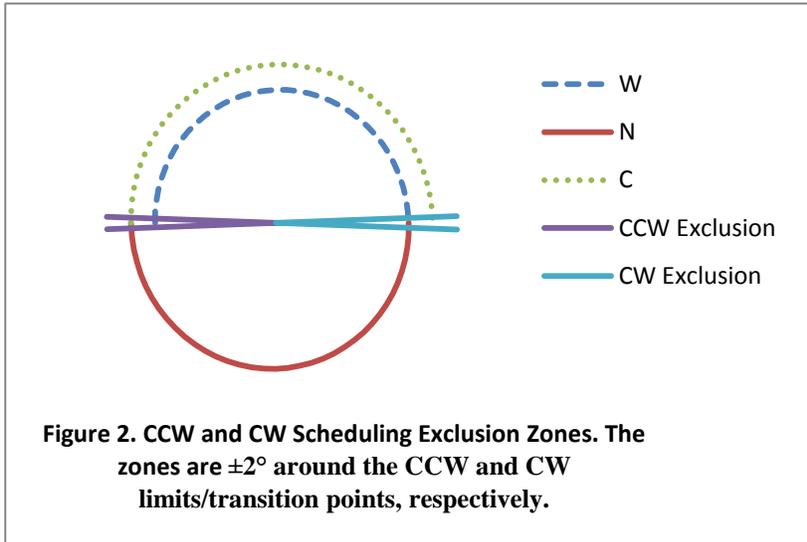


but will track beyond those limits if already tracking a source. In this case the command "limits" should be used as the wrap limits, not the tracking limits.

In this document, the descriptions are general, independent of the actual limits, source positions, and the latitude of the antenna. The figures give specific values of limits and source positions for illustration purposes only. For example cases, the CW figure is omitted if it is essentially a mirror of the provided CCW figure.

SKED Scheduling

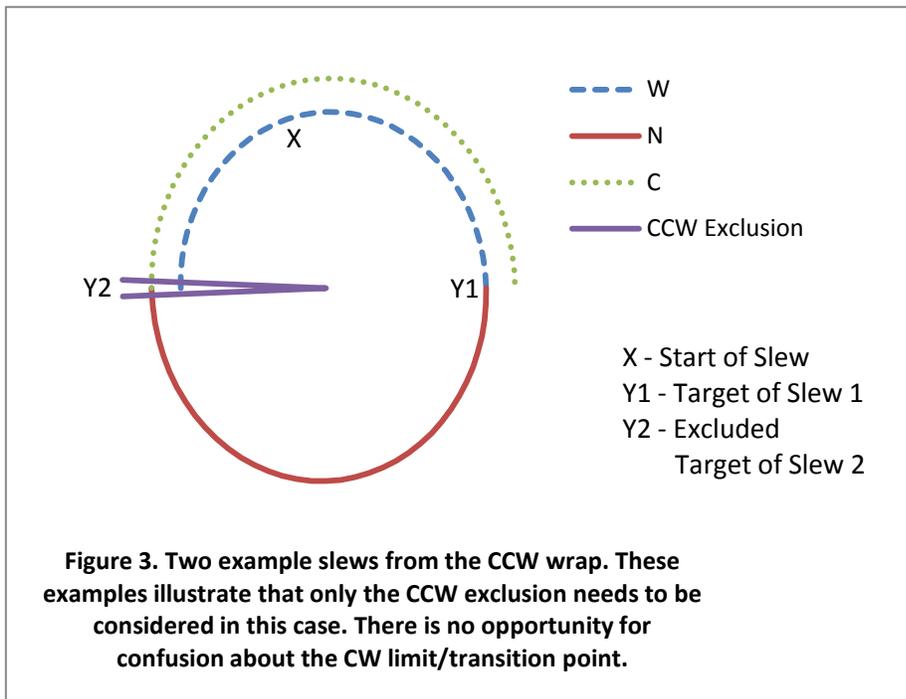
When making a schedule, SKED keeps track of the antenna position and allows for the needed time to slew from one source to another. Cable-wrap in Az-El antennas complicates this since there are two ways to get to some new sources. SKED assumes the antenna will always go the shorter way when there are two choices.



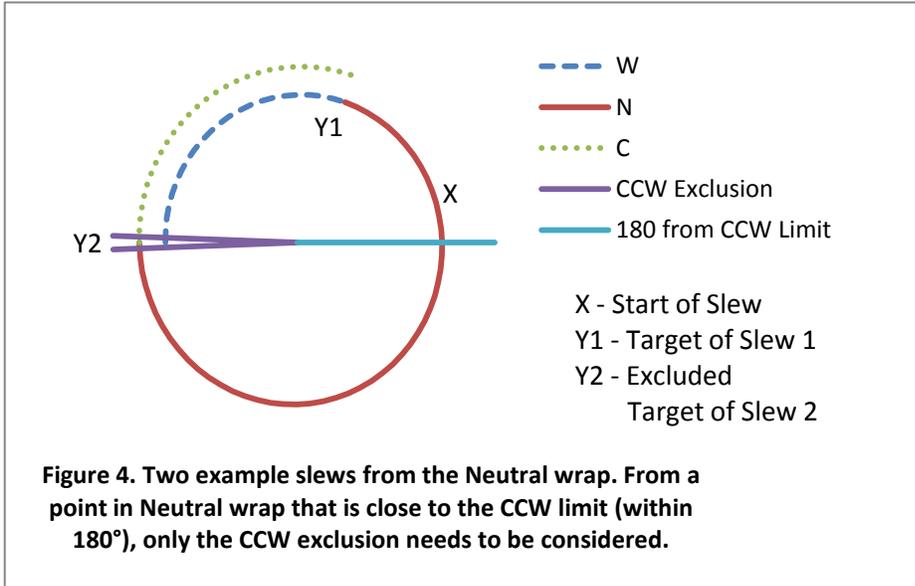
There are some subtle effects that need to be considered. The most important issue being that the locations of the end of the cable-wraps are not always accurately known. Another way to say this is that the antenna and SKED don't necessarily agree on the location of the limits. This affects both transition points between the Neutral region and the Overlap region and the extreme limits of the cable-wraps. To deal with this issue,

SKED makes a zone of exclusion of $\pm 2^\circ$ at the transition points, which are the same for the wrap limits (see Figure 2). SKED will not schedule a new source if it falls in the exclusion zone. However, to avoid missing these parts of the sky entirely (about 2% overall), there are some cases when the exclusions

don't need to be used; these are described next.



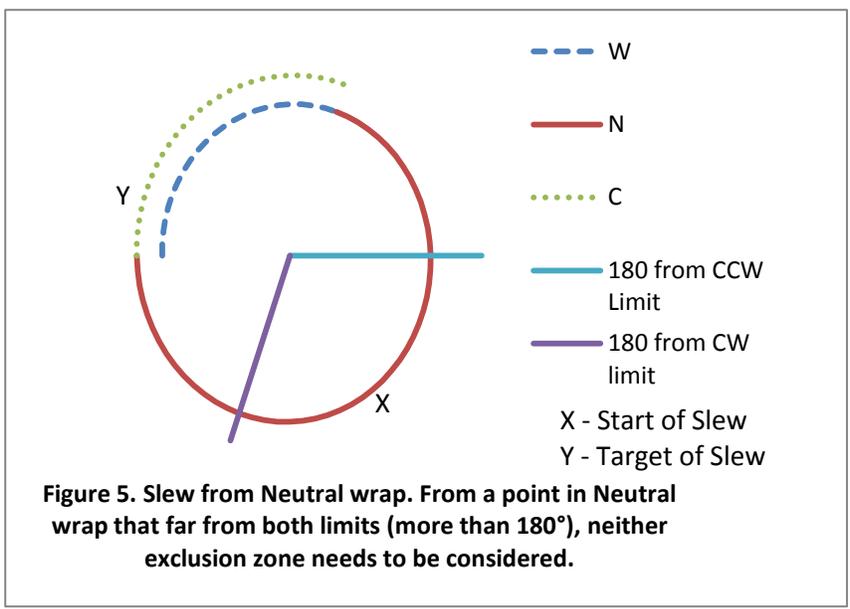
If the antenna starts out its slew on the CCW wrap or close to it (within 180° of travel to the CCW limit while on the Neutral wrap), SKED need only exclude the zone around the CCW limit (see Figure 3, this page, and Figure 4, next page). If the antenna starts on the CW wrap or close to it (within 180° of travel to the CW limit on the Neutral wrap), SKED



need only exclude the zone around the CW limit. If the antenna starts on the Neutral wrap and not close to either limit (more than 180° of travel to both CCW and CW limits), neither exclusion zone need be used (see Figure 5). The zone of exclusion must be applied based on the time that the source would be commanded, i.e., shortly after the previous scan.

A second issue is that when a new source is commanded, it may not currently be in the wrap that it will be observed in. To deal with this, SKED must exclude sources that would move off the end of a wrap (actually, pass into the exclusion zone, 2° “inside” the limit) between the time it is commanded and the end of the scan that will include it. Sources that would transition from the neutral region to the overlap region do not need to be excluded. **As of this writing, SKED does not fully implement this paragraph, but should soon. Currently, it does exclude sources that would cross a cable-wrap limit during an observation, but not those that would cross before the scan begins.**

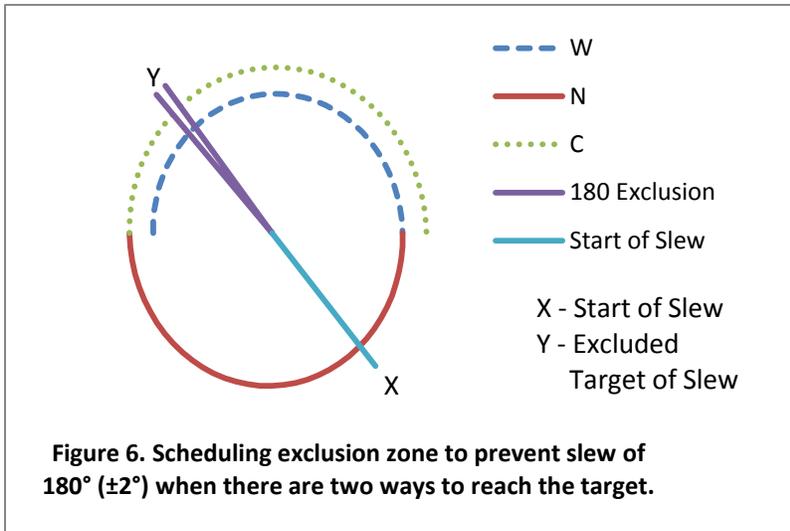
A third issue is that if there are two ways to get to a source and the resulting slew is close to 180°, due to the details of timing, the antenna may not agree with SKED on which one is shortest. Thus it is prudent to have a ±2° zone of exclusion around 180° from the position where the antenna starts the slew from if



the new point can be reached two ways (see Figure 6, next page). It may not be necessary to exclude a source that would enter that zone of exclusion before the slew is over, but it is prudent to do so also.

Antenna Interface (*antcn*) Implementation

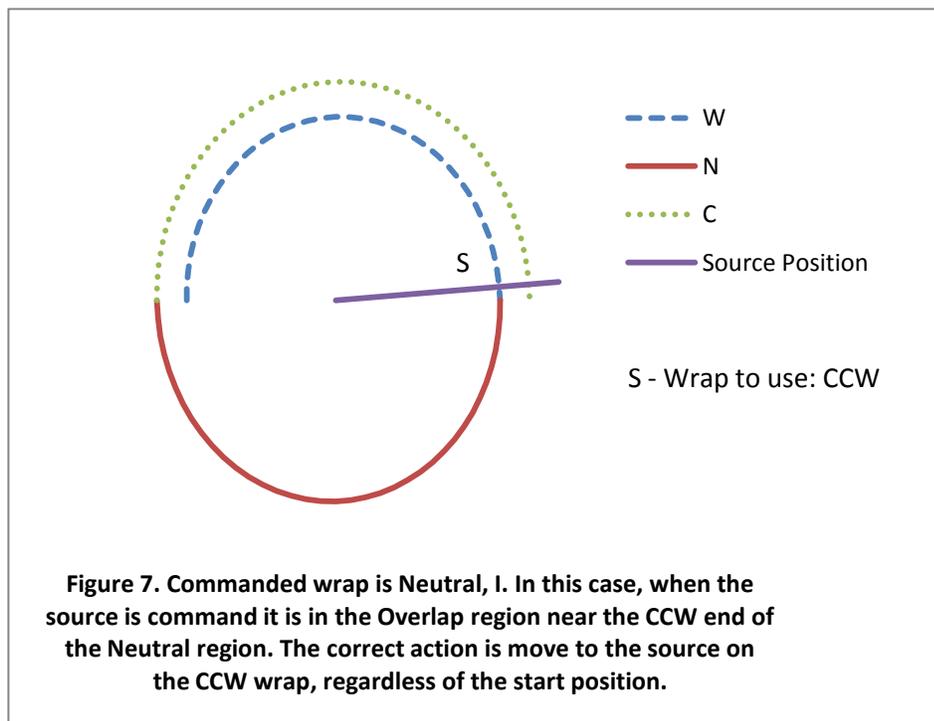
The FS passes the source information to the antenna. If SKED and the antenna agree within 2° on where the wrap limits are and SKED implements



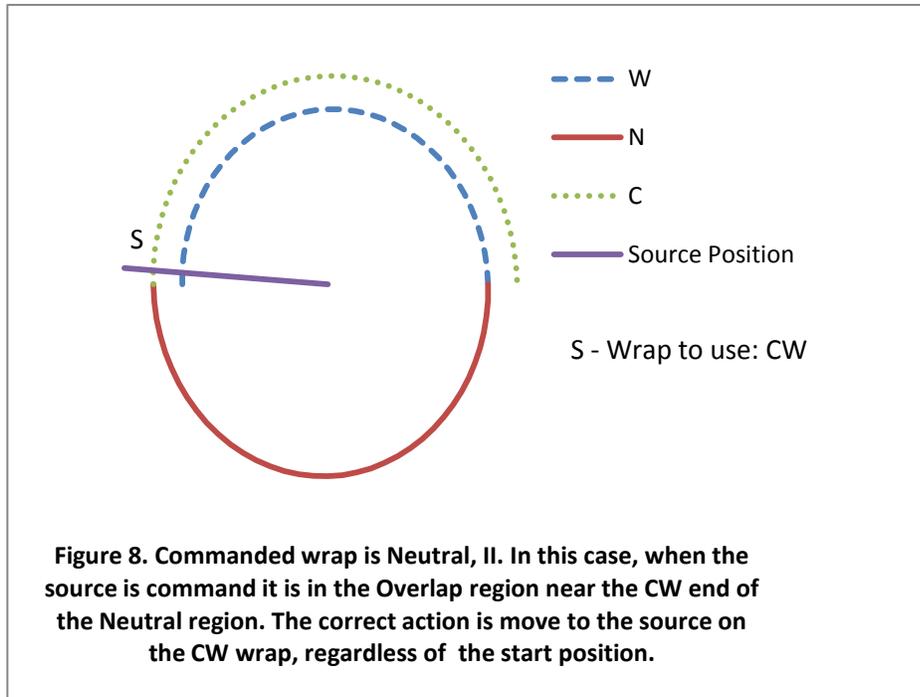
the exclusions described above, there should not be a case where the antenna goes the wrong way during normal execution of a schedule. However, to make the system more robust (and to allow complete control of antennas), the FS provides a “cable-wrap” argument in the “source=...” command. It is the fifth argument and can take on values: CCW, NEUTRAL, CW, or null (empty). These values indicate the wrap for the source when it is commanded.

For schedules, normally only CCW, NEUTRAL, and CW are used (a null value indicates the antenna should go the quickest way, but is not normally used in schedules). The FS does not interpret the cable-wrap argument, but just passes it onto the antenna interface, *antcn*. It is the responsibility of the antenna interface to implement the wrap request, if it can. The following discusses how the wrap parameter should be interpreted. The SKED exclusion zone is not relevant to this discussion.

If the source being commanded is on the wrap being requested, there is no ambiguity about what to do. However, if the source is currently on a different wrap than the one requested, an appropriate action needs to be taken to preserve the correct execution of the schedule. To determine the correct action it is necessary to make the assumption that the source is being commanded shortly before it will be



observed. A difference between the expected and actual wrap is most likely due to an error in the SKED’s model for the location of the wrap limits or the source is being commanded at a slightly different time than SKED expected. Either way, the source will probably enter the expected wrap soon. In some cases the source could be observed on either wrap, but to make subsequent

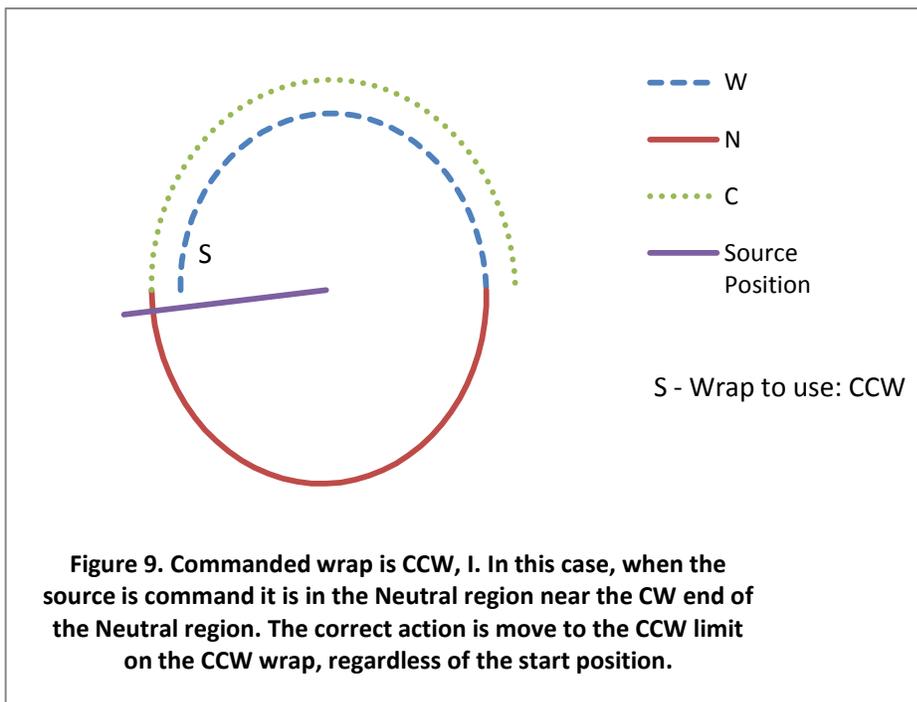


observations work correctly, it is necessary to get the antenna on the correct wrap from SKED's point-of-view. There are three cases of conflict to consider:

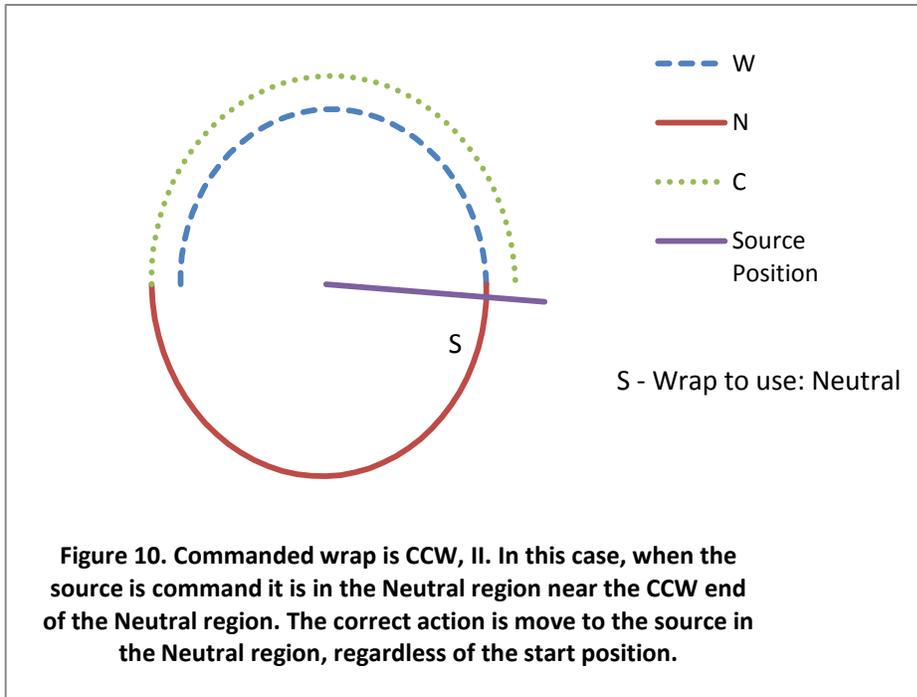
(1) The source is commanded as "NEUTRAL", but it is currently in the Overlap region. If the source is near the CCW end of the Neutral region, the antenna should be moved to the source's position on the CCW

wrap (see Figure 7, previous page). Alternatively, if the source is near the CW end of the Neutral region, the antenna should be moved to the source's position on the CW wrap (see Figure 8). With this approach, the telescope will, in either case, smoothly transition to the Neutral region when the source reaches it.

(2) The source is commanded as "CCW", but is currently in the Neutral region. If the source is near the



CW end of Neutral region, the antenna should be moved to the CCW limit to wait for the source to enter the Overlap region (see Figure 9). If the source is near the CCW end of the Neutral region, the antenna should be sent to track the source's position, which by assumption is in the Neutral region (see Figure 10, next page).



(3) The source is commanded as "CW", but is currently in the Neutral region. If the source is near the CCW end of Neutral region, the antenna should be moved to the CW limit to wait for the source to enter the Overlap region. If the source is near the CW end of the Neutral region, the antenna should be sent to track the source's position, which by assumption is in the Neutral region.

If a source is commanded that is beyond the limits of the antenna, in general the antenna should go to that limit and "track" as close to the source as possible (so-called "tracking at the limit") so that when the source does come out of the limit it can be tracked as soon as possible. This is straightforward for axes that do not have "wraps", i.e., not azimuth (in other words: Elevation, X, Y, Hour Angle, or Declination). For azimuth, the correct handling of the limits is described above in cases (2) and (3). Specifically this means that if the source is beyond the limit of the wrap where it is supposed to be observed, the antenna should wait at that limit for the source.

Likewise, if the antenna is tracking a source that moves into a limit, the antenna should adopt the approach of "tracking at the limit". In particular for azimuth, it should not attempt to "unwrap" to get to the source. This in some sense is a detail of the antenna's tracking but it affects the selection of cable-wrap as well, since not unwrapping in this case will allow the slewing calculation for the next source to have the best chance of being accurate.

Experiment Operations

The most important issue for cable-wrap during experiment operations is to make sure the antenna starts on the correct wrap when the schedule is started or re-started (e.g., after a power failure). This may sound trivial, but particularly when restarting a schedule, it is important to make sure there is enough time for the antenna to get to the correct wrap. If there isn't, a later source should be chosen for which there is enough time.

Another important issue is that the antenna must actually get to the designated wrap. If the antenna interface implements the "source=..." command's wrap parameter, it may be that no special effort will

be required. However, it is still good to verify that the antenna is in fact going to the correct wrap so that corrective action can be taken if it is needed. If the wrap parameter is not implemented and the requested wrap is different from the current wrap and the requested wrap is not "Neutral", it may be necessary to intervene manually (perhaps commanding the antenna to intermediate points along the way) to force it onto the correct wrap.

During normal operations once the antenna is on the correct wrap, no errors should occur in the selection of cable wrap. If any do, usually notable as unexpected "unwrapping" of the antenna while trying to get to a source, manual intervention may or may not be useful in correcting the antenna motion. It may be most expedient to just allow the antenna to catch up to the schedule over the next few sources. However, please be sure to contact the IVS Coordinating Center (ivscc@ivscc.gsfc.nasa.gov) to report the problem and be sure to note the event with comments in the log and in the experiment's e-mail Stop message. The Coordinating Center will adjust SKED's model of the antenna to prevent this from happening again.

Note that if a source from the schedule is commanded a long time (hours) before it is to be observed (so that it changes wrap before being observed), it is not in general possible to make sure it will be observed on the correct wrap without intervention. This situation might arise if the schedule is started many hours before the first observation.